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FUSION OF HANDS.

WITH PLATES XLIII—XLIV.

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XIII. FUSION OF HANDS.

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CASES of polydactylism in which the increase of the number of fingers clearly springs from the fusion of two more or less complete hands and forearms are extremely uncommon. There are several, for the most part rather imperfect, accounts of this condition as seen in living persons, or in undissected specimens, or recorded in the plates of old authors, but there seems to be no dissection like the one about to be described in any museum, nor any description of a similar dissection in literature. This one, indeed, was described forty years ago by Harvard's distinguished Professor of Morbid Anatomy, the late Dr. J. B. S. Jackson, but the dissection had not been carried far enough to show some of the most important features, the account was inadequate, and in parts wanting in the anatomical accuracy which is so essential, but can hardly be expected from any other than a trained anatomist. Moreover the account appeared merely in an abstract of the Proceedings of the Boston Society for Medical Improvement which was published in the American Journal of the Medical Sciences, Vol. XXV, January, 1853, p. 91. It is practically buried. It is indexed in the Journal as "Malformation" without any qualification whatever. Thus this most remarkable case is not mentioned by the most exhaustive writers on the subject. The specimen originally belonged to the Cabinet of the Boston Society for Medical Improvement which some years ago came into the possession of the Harvard Medical School. It seems proper to bring it forth from the obscurity in which it has remained so long, especially as it is particularly valuable in connection with a recent observation on the living by Dr. F. Jolly of Berlin.

A preliminary glance at the bibliography will help to the better appreciation of this case. The literature is far from satisfactory. It is all the more obscure from the diversity of interpretations and from the difficulty which often exists in deciding in which class a particular case belongs. The following seem to be undoubted cases of the fusion of two more or less perfect hands. In some of these cases we have no question that the fusion extends into the forearm and even beyond the elbow.



1. RUEFF. *De Conceptu. Frankfurt*, 1587, *Plate 41*. In the text it is stated that there are twelve fingers but, according to Morand and to Taruffi, the plate shows a child having two hands joined by the ulnar side, each with five fingers. There were also double feet.

2. AMBROSINI IN ALDROVANDI. *Monstrorum Historia. Bonn*, 1642, *pp. 495 and 497*. A foetus with two hands on each arm with five fingers each and joined on the ulnar side.

3. KERKRING. *Observat. Anat. Amsterdam*, 1670, *p. 15, Obs. XX, with plate*. A skeleton of a boy with seven fingers on each hand of which the longest were in the middle. On the right there were seven metacarpals but a thumb could not be recognized. On the left hand there were apparently five metacarpal bones. The first phalanx of the thumb arose on the outside of the 7th finger. One foot had eight toes and the other nine. [This is on the authority of Taruffi. It seems the least certain of these cases.]

4. DU COURAI. *Journal des Savants. 1696*. An infant with eight fingers on the right hand, of which the two indices were joined together as well as the two little fingers. [It is not easy to see how this could occur unless the hands were put face to face.] There were seven fingers on the left hand of which the indices were joined and the rest separate. It seems from the context that there were no thumbs. Both hands were bent inwards on the wrists and could not be extended. The metacarpus was a third longer than usual. Each foot had seven toes, of which the great toes of each foot were united. The head was monstrous.

5. GIULIO OBSEQUENTE. *Grammatico Latino. De prodigiis*. A girl with four hands and four feet.

6. WIRTENSOHN J. *Dissertatio. Berlin*, 1855. A human monster with four hands and four feet in the Berlin Museum. [Taruffi, from whom this reference is taken, states that he was not able to verify this observation.]

7. MURRAY. *Medico-Chirurgical Trans. Vol. XLVI, London*, 1863. This is a very noteworthy case especially in connection with the one which is the subject of this paper. A woman, thirty-eight years old, living at Brighton, had two hands of four fingers each on the left arm, united at the radial side. "The fingers of both hands are clubbed at their tips. The middle and ring fingers of the supernumerary hand are webbed as far as their proximal joints and the movements of the fingers of this hand are somewhat stiff and imperfect. The thumbs seem to be represented only by the prominence on the dorsal surface seen in figure 3." This is a very poorly shown little projection apparently on the back of the proximal phalanx of the index of the normal hand. [It may be advisable to point out that when, as in this case, we have two hands united by corresponding sides, one of them must be a right hand and the other a left hand. The one which is of

the same side as the arm is the normal hand; the other the extra one.] The two sets of fingers could be opposed to each other. It seems that the woman when at work scrubbing the floor rested on the back of the flexed carpus. Mr. Murray says: "From the rigidly arched conformation of the metacarpal portion of the double hand, it is evident that she could not lean on the palm." The woman was otherwise well-formed. There was nothing of the kind in her family as far as she knew, and she had a normal child. The rest may be given in Mr. Murray's own words. "The shoulder joint is natural. The external condyloid ridge of the humerus is strongly defined. The elbow joint may be fully extended, but flexion cannot be carried further than is represented in Fig. 1," [say to an angle of 120° with the humerus] "and the impediment seems to be the unusually large coronoid process of the ulna. The muscles and tendons of the forearm are so prominent that it is not easy to decide whether there is a second radius or ulna; but after numerous examinations made under favorable circumstances, I feel sure that the duplicity of bony structure begins at the carpus. Pronation and supination are freely performed." It will be necessary to review these statements in the light which the present case throws on the internal structure of the forearm.

8. GIRALDES. *Maladies Chirurgicales des Enfants*. A case of a child's hand with eight fingers in two sets and no thumb.¹ A clear case of two nearly perfect hands fused at the radial sides. Giraldes refers to two similar specimens which, having injected and dissected, he placed in the *musée de l'amphithéâtre des hôpitaux*. Of these Fort² says in 1869, "*Nous ne les avons pas trouvées*."

9. GIRALDES. *Bull. Soc. Chirurg. Nov. 1865*. M. Giraldes said: "I have had an opportunity to see in my service a case of two entire hands on a single forearm. M. Guer-sant has seen the same person."

10. FUMAGALLI. *Sulle deformità congenita della ditta. Annali Univ. di Med. Milano. Vol. CCXVI, p. 305. 1871*. A girl of four months without family predisposition had the right hand with eight fingers and no thumb. The two sets were united by the radial side. The double hand was ankylosed at a right angle to the forearm. The extra fingers had less motion than the normal ones. Their metacarpal bones were incomplete.

11. KUHN. *Virchow's Archiv, Band LVI, 1872*. A German recruit twenty-one years old. Each hand consists of the ulnar half of two hands fused. The left hand consists of five fingers and no thumb. Three of the fingers apparently are of the left hand to which are added the ring and little fingers of a right hand. The right hand is less symmetrical. There are the three normal fingers of the ulnar side to which are added two fingers and a rudiment of a third of a left hand. According to the drawing, there is no abnormal flexion.

¹ This is the case erroneously attributed to Lanceraux in Ziegler's *Lehrbuch der pathologischen Anatomie*, 1892.

² Des difformités congénitales et acquise des doigts. Thèse, Paris, 1869.

The man was a workingman, and it is stated could do only coarse work (grobe Arbeiten). Nothing is said of the motions of the elbow.

12. GERRHINI. *Gazetta Med. Ital.-Lombardo*. No. 51. 1874. A boy five years old had six fingers on each hand divided into two groups. It is a clear case of the fusion of the ulnar sides of two hands.

13. LANGALLI. *La scienza e la pratica*. Pavia, 1875. An account of a wax model of a girl's right hand found in a museum. Four fingers of three phalanges represent the normal hand. The other four represent the absent thumb. Again there seems no doubt that this is a case of fusion.

14. F. JOLLY. *Festschrift, Rudolf Virchow gewidmet*. Band I. Berlin, 1891. This case is the most important one. The individual presenting the peculiarity was a living man, twenty-five years old, without hereditary predisposition, but of peculiar and deficient mental organization. The deformity was on the left arm, which from the shoulder down was smaller and shorter than the right. The fingers were in two groups of three, each consisting of a middle, ring, and little finger. The fingers of the group on the outer, or radial side, were those of a right hand. One proximal phalanx of the extra set was broad at its base so as to articulate with two metacarpal bones, of which there were seven in all. The internal condyle of the humerus and the normal ulna were easy to feel. There was no distinct external condyle and no head of the radius could be made out. Along the front of the humerus in the region where the biceps should be "there is felt instead of that muscle a strong bony ridge which runs to the bend of the elbow and ends in a blunt prominence." As well as could be judged on the living, it would seem as if on about the lower two thirds of the humerus there was an outgrowth, or another bone fused with it on the front and outer side. The outer bone of the forearm feels at the wrist more like an ulna than a radius. The man can raise his arm at the shoulder but little above a horizontal line. It can, however, be brought passively to a vertical position. The photograph shows a flattening in the deltoid region. The elbow can be flexed actively only to an angle of about 150°. Passive flexion does not exceed 120°, the above mentioned bony process locking the joint. There is next to no pronation and supination. The hand can be both actively and passively flexed and extended. So can, also, the fingers either individually or in groups. The photograph shows a tendency to flexion and pronation of the hand which the author does not mention. Dr. Jolly thinks one would be inclined to believe that the ulnar parts of two hands and two forearms had been fused together while the radial constituents had in part been lost. He says that whether his interpretation, made on the living, is the correct one will be shown certainly when there is a chance to examine an analagous case.

It should be noticed that of the preceding cases in 1, 2, 5, 6, and 9 there are two practically complete hands. In cases 1 and 2 (if there be no mistake) these are joined on the

ulnar side. The point is not mentioned in cases 5, 6, and 9, which are of little value. Case 3 is unsatisfactory. It is certainly allowable to question whether the phalanx growing in one case from the seventh finger is rightly called the thumb. If it be not a thumb this case may be considered the result of the fusion of the ulnar portions of two hands. Case 4 is also wanting in clearness. This leaves cases 7, 8, 10, 11, 12, 13, and 14 showing fusion of the ulnar parts of the hands with suppression of more or less of the radial parts. For reasons which will appear later it is probable that in several of these, the duplication of one side and the suppression of the other are not limited to the hand.

The next case is placed last, out of the chronological order, because, though the polydactylism is also due to the fusion of a part of an extra hand, it differs extremely from the others.

15. CARRÉ. *Séance publique de la Société Royale de Médecine, Chirurgie, et Pharmacie de Toulouse.* 1838, pp. 28-30. A goldsmith had on his right arm, beside the normal hand, an extra thumb and index finger. The latter thumb was next to the normal one and the index further from it showing that of course they belonged to a left hand. Indeed the two thumbs were united and had, according to Carré a common metacarpal joint. They were of equal size. They were flexed and extended together and had the power of spreading apart. The next finger arising from the outer side of the thumb was shaped like an index and had free motion in flexion, extension, and abduction. Besides the radius and ulna of the normal arm there was an extra radius on the outer side of the former, joined to it at the wrist, but separated from it above by an interval that could be felt. It had a joint of its own at the elbow. The motion of each bone could be felt, though pronation was impaired. The wrist was broad, implying the presence of additional bones. Nothing is said of a metacarpal bone for the new index.

The present specimen is the left arm of a German machinist thirty-seven years old who died of chronic diarrhoea at the Massachusetts General Hospital in Boston in March, 1852. The arm was dissected by the late Dr. Ainsworth and made into an old-fashioned dried and varnished preparation showing most of the muscles of the upper extremity and the chief arteries and nerves of the forearm and hand. The parts, of course, are much shrunken and distorted, but the specimen has kept unchanged. There is no account of any deformity excepting of the left arm. From a hint in the Hospital Records and from an anecdote told by a physician who remembered him, it may be inferred that the patient was of loose morals and of a peculiar temperament, which is recorded from the similarity to Dr. Jolly's case. Figures 1 and 2 of plate 43 represent a cast taken after death which also is in the Museum of the Harvard Medical School. It shows a left forearm and a very broad hand having four normal fingers and, in place of the thumb, the three inner fingers of a right hand which were smaller than the others. The hand is flexed and somewhat pronated.

The dissected specimen is in much the same position but less strongly flexed. The carpus and metacarpus are arched transversely so as to form a deep hollow in the hand. Dr. Jackson said in his report of the case to the Boston Society for Medical Improvement in the summer of 1852: "the hand was not merely very useful to him in the way of his business, but gave him some advantages, he thought, in playing upon the piano, upon which instrument he was a performer. The three upper fingers, supposing the hand to be laid in a state of semipronation, were used efficiently as a thumb to oppose the three¹ others. Various observations were made upon the motions of the hand and fingers." Unfortunately these were not recorded in the hospital records and no notes bearing on them can be found among Dr. Jackson's papers. The left arm was shorter than the right. Dr. Jackson gives the length of the left forearm as $8\frac{1}{2}$ inches and that of the humerus as 10 inches, the right ulna measuring nearly 10 inches and the humerus 13 inches. The scapula (Plate 43, fig. 3) is very peculiar. The supra-scapular notch is broad and so deep as to pass below the spine. The spine is so slanted that what is called the upper surface of the acromion looks almost directly outward. It is moreover very slight. The supra-spinous fossa is rudimentary. Its anterior portion is wanting and most of the posterior part of the floor is convex instead of concave. Dr. Jackson had perfectly recognized that the bones of the forearm were two ulnae, and that there was no radius; but the parts about the elbow were so hidden by the dried muscles that very important features could not be made out. I therefore had the specimen photographed before it was disturbed and rewrote the description of the soft parts. Then softening the dried muscles by a steam of almost boiling water I examined thoroughly the bones at the elbow and finally separated the arm from the forearm. The bones were then photographed. The wrist and hand were not further dissected as the preparation gave a good view of the dorsal aspect of the carpal bones.

THE BONES. The forearm consists of the normal left ulna and of a right one in the place of the radius. The left one shows little that calls for comment, excepting that there is a projection outward at the place of the lesser sigmoid cavity to join a corresponding projection from the other ulna. The upper surface of this projection articulates with the humerus. At the lower end the styloid process is less prominent than usual, and the head rather broad. The right or extra ulna is put on hind side before, that is the back of the olecranon projects forward over the front and outer aspect of the humerus. If the reader will place his right forearm on the outer side of the left one he will see that it is necessary for the ulna to be thus inverted if the thumbs are to touch and the palms to be continuous. This olecranon is thinner, flatter, and longer than normal. The coronoid

¹ Dr. Jackson says "three" instead of "four" as he looked on the normal index as a central finger with three on either side of it—a view to which I cannot agree,

though it has some support in the plan of the extensor tendons.

process is rudimentary. From the side of this process and from the shaft just behind it arises the projection already referred to which meets a similar one from the normal ulna. (Plate 43, figs. 4, 5.) On the front of this there is a small articular surface looking forward which suggests a part of the convexity of the head of the radius. (Plate 44, fig. 1.) The upper articular surface shows a fissure separating it from the side of the olecranon which is not found in the normal ulna. These projections which touch each other are held together by a strong interosseous ligament. The lower end of this ulna is very like the other only somewhat broader. The mode of union of the lower ends could not be seen without unwarrantable injury to the specimen. There can hardly have been any definite movement between these bones. Perhaps the ligaments may have permitted some irregular sliding, but it is impossible to know. These bones have been described first because their nature is very clear and, once understood, is a key to the more difficult interpretation of the lower end of the humerus.

The upper end of the humerus, concealed as it is by dried muscles, presents nothing noteworthy. There is no roughness for the attachment of the deltoid though the place for it is exposed. At the lower end the internal condyle is normal. It is quite unmistakable and is the most evident starting point. On the posterior surface is an olecranon fossa containing the normal olecranon. Beyond this is a thick rounded swelling, which, however, can hardly have been prominent before dissection. This is the normal outer condyle of the humerus *plus* another of a right humerus applied to the normal bone at nearly a right angle. A prominence somewhat to the outer side of the front of the normal humerus represents the internal condyle of the right one. Between this and the fused external condyles is the joint for the right olecranon. There is but a faint trace of a fossa above it. Between the two internal condyles is a very small coronoid fossa on the front of the normal humerus. (Plate 43, fig. 4; plate 44, figs. 2, 3.) Thus it appears that to this left humerus is added a part of the lower end of a right one, so applied that the outer condyles are fused and the right inner condyle projects forward. To illustrate this I have made a model (Plate 44, fig. 4), by sawing off obliquely a great part of the outer condyle of a left humerus and applying to it a part of the lower end of a right humerus cut in the same way. Each humerus bears its own ulna. If the lateral expansions from the side of the coronoid processes and of the shaft behind them could be put on this would represent strikingly the relation of the bones at the elbow.

The dorsal side of the carpus was well exposed in the original dissection but the description was not anatomically correct. The palmar aspect cannot be studied. The carpus is so convex that it is not possible to get a satisfactory photograph. The relations of the bones are shown in the diagram in which they are represented as in a level plane. The proximal row consists of three bones besides the two pisiforms. At either side of the wrist is a cuneiform (*os triquetrum*), the dorsal

surface of which is uncommonly large. Between them is a bone which evidently is the result of the fusion of two semilunars. Its upper border is slightly notched. The pisiforms in the tendons of the ulnar flexors are displaced above the wrist on to the ulnae. Extension of the hand would have brought them on to the cuneiform bones. At each end of the second row there is an unciform bearing the little and ring fingers. Each rests on the corresponding cuneiform and touches the semilunar. Next come the two ossa magna, very symmetrically disposed, each bearing the metacarpal bone of the middle finger. Their anterior halves diverge so as to leave an interval between them,

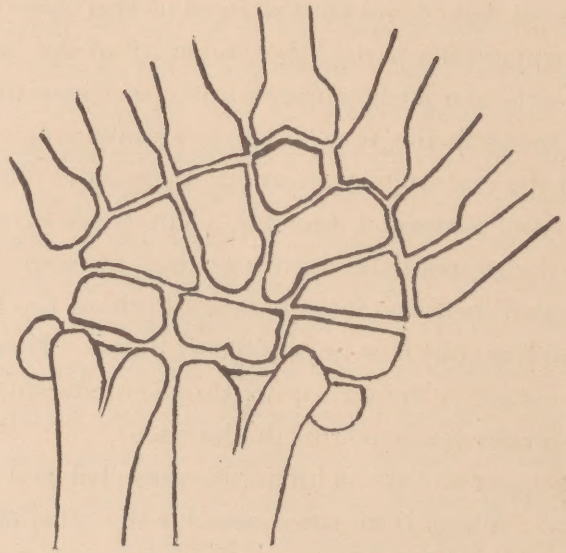


DIAGRAM OF THE DORSAL ASPECT OF THE WRIST.

behind which they touch each other, their heads resting side by side in the middle bone of the first row. In the notch between these bones is the trapezoid (*os multangulum minus*) bearing the left index finger. Each middle finger touches it, the extra one by a broader surface than the normal one of the left hand. Still it is very symmetrically placed, so that from a view of the carpus alone it would be very hard to say to which side it belongs, but a glance at the specimen or at the cast is enough to show that the index finger belongs to the left hand. The metacarpal bones and phalanges require no special description. Those of the extra hand are somewhat smaller than the normal one.

THE MUSCLES. In this account Dr. Jackson's description is followed as closely as possible. "The tendons of the *latissimus dorsi*, *teres major* and *minor*, *subscapularis*, *infraspinatus*, *pectoralis major* and *minor* are shown in the preparation." No mention is made of the *supraspinatus*. It has been stated that its fossa is rudimentary, if present at all it must have been very small. Dr. Jackson says that the *deltoid* had been removed. The absence of the roughness for its insertion and the lightness of the spine of the scapula and the acromion have been noted. These facts imply that it was small; an interesting point to be returned to later. "*Coraco-brachialis* small." The *biceps* is obscure. There seems to be a small long head with probably a short head from the coracoid joining it low down. The long head is tendinous in the middle of the arm. This muscle is inserted into the extra

internal condyle on the front of the humerus and perhaps also into the bone above it. "One *triceps* sufficiently developed, with its three heads, and inserted into the perfect ulna. A second *triceps*, however, exists which is quite imperfectly developed; one head arises from just below the head of the humerus . . . and a second from the lower part of the humerus. It is inserted into the imperfect olecranon but sends a tendon to the corresponding inner condyle, and receives a large slip from the other *triceps*; in structure it is muscular at each extremity and tendinous midway. A supernumerary slip of muscles," appears through the capsule of the shoulder joint, like the long head of another *biceps*, "passes under the tendon of the *pectoralis major* and is inserted into the" extra internal condyle. "There was no well defined *brachialis anticus*."

"In the forearm the muscles usually connected with the radius and thumb are of course wanting. The superficial flexor of the fingers arises from the inner condyle corresponding to the perfect ulna; and sends a tendon to each finger, excepting the little finger of the imperfect side" [*i. e.* of the extra hand] "also a slip from the tendon of the index finger to the deep-seated tendon of the same." The deep flexor arises in two parts. That for the normal hand arises chiefly from the normal ulna, partly from the interosseous membrane. The portion for the index has its muscular belly to a great extent separate from the rest. The part for the extra fingers arises almost if not quite exclusively from the inverted ulna. The little finger has only a small slip given off from the side of the tendon to the ring finger. "*Flexor carpi ulnaris* well developed on the perfect side, but on the other indistinct." This indistinctness probably applies to the muscular belly, for the tendon is perfectly plain, and about as large as the normal one. Each goes to the pisiform bone and probably further. The second one seems to arise from the fibrous or muscular expansion at the outer side of the forearm near the inverted olecranon. No mention is made of a *palmaris longus* but a prominence in the cast indicates that it existed. "*Pronator quadratus* quite well marked, and also the *interossei*." There is a slip of muscle or fascia, now dried and shrunken, running from the muscular mass below the internal condyle to the inverted ulna just below the elbow, strongly suggesting a rudimentary *pronator radii teres*.

The system of the extensors is very complicated, and owing to the distortion of the dried muscles, not easy to make out perfectly. Still a good deal can be added to the original description. No *extensores carpi ulnares* are found, nor is there any mention of them. They probably existed, however; as the groove for the tendon is slightly marked at the lower end of each ulna. A muscle, which may represent one of them, runs along the outer border of the forearm. It springs from a muscular mass on the free edge of the inverted ulna and is inserted apparently into the outer side of its

head sending a small slip to the base of the little finger. No such muscle has been preserved on the normal side. The common extensors of the fingers may be described as follows: A fleshy mass arises from the outer side of the normal olecranon, between it and the fused outer condyles, which sends extensor tendons to the four normal fingers. The one to the index is very small and soon separates from the others. There are the usual cross connections over the metacarpus between the tendons of the inner three fingers. An *extensor proprius indicis* arises from the middle of the ulna and the interosseous membrane. The extensor of the extra hand arises partly in common with the other from the fused outer condyles and partly from the region of the inverted olecranon. It sends tendons, more or less fused, to the three extra digits and a small slip to the index of the normal hand which joins near its insertion the tendon of the *extensor proprius indicis* already mentioned. There arises also from the back of the inverted ulna and perhaps from the interosseous membrane a second *extensor proprius indicis* which is very much the largest of the four extensor tendons going to that finger. The next largest is the *extensor proprius* of the normal hand. There arises also from the back of the inverted ulna near the wrist another small muscle with a tendon going to the back of the middle finger of the extra hand. Near this, but still lower, was another small muscle, the tendon of which had been cut near the base of the metacarpus.

THE ARTERIES. The brachial divides at about the junction of the middle and lower thirds of the humerus. The main continuation, which is the ulnar proper, runs deeply under the band thought to represent the *pronator radii teres*, to the deep part of the forearm where it gives off the interosseous. Above the elbow there is a branch running backward between the internal condyle and the olecranon. The interosseous branches are not easy to trace. There seems to be an anterior interosseous and three branches on the back of the forearm, one running on the membrane and one along each bone. At least two of these share in a network on the back of the carpus. Having reached the hand the ulnar artery runs obliquely across the palm to the cleft between the two sets of fingers, supplying the four normal fingers and the nearer side of the extra middle finger. (Plate 44 fig. 5.) The other branch of the brachial crosses the median nerve and runs, apparently superficially, to the outer side of the forearm. It supplies the little and ring fingers and the corresponding side of the middle finger of the supernumerary set. There is no anastomosis in the palm between the superficial branches of the two arteries. Each gives off a deep branch at the usual place, which forms a deep palmar arch from which some interosseous arteries spring. There is also an arterial network over the front of the carpal bones. The arteries of the deep parts of the hand cannot all be seen.

THE NERVES. The ulnar nerve proper, pursues a normal course and supplies the palmar aspect of the little finger and half the ring finger of the normal hand. Near the

wrist it gives off a very small posterior branch, which is not well preserved but which seems to have had less than the usual distribution.

The median nerve is normal as far as the elbow, running to the inner side of the extra internal condyle. It is then lost in the dried fibers of the *flexor sublimis*, from which it emerges in two main divisions near the middle of the forearm. The inner of these soon divides into two, of which one supplies the adjacent sides of the ring and middle fingers and the other those of the middle and index fingers of the normal hand. The outer division of the median supplies the outer side of the index and both sides of the extra middle finger and one side of the extra ring finger. One of the branches to the index gives off a dorsal branch, and there is a doubtful one for the extra middle finger. The musculospiral nerve passes behind the humerus as usual. A nerve which is undoubtedly continuous with it emerges from the hardened muscles over the fused outer condyles. It seems to be the radial branch changed into an ulnar. It runs with the extra ulnar artery to the hand, and sending a deep branch into the palm, goes to the little finger. Its continuation is plain along the side of the little finger nearest to the ring finger. There is a detached branch on the other side of the little finger which in all probability came from it. The deep branch sends a twig along the metacarpal bone of the ring finger. It probably supplied the side of the ring finger left unprovided for, but this is uncertain. Assuming this to have been the case, each ulnar nerve supplies the palmar surface of one finger and a half, the median supplying the remaining fingers of both hands. Unfortunately no dorsal branches except those mentioned have been preserved.

Precisely of what nature and how extensive the movements in this extremity may have been is not easy to determine, but certain main facts are pretty evident. It is very probable from the structure of the spine of the scapula and the want of a deltoid ridge on the humerus that this muscle was a weak one. It is certain that the joint at the elbow allowed but a very limited amount of flexion. There can have been no true pronation and supination whatever, though some irregular movement of the two ulnae on the humerus may have been possible. The cast with the strong cords at the front of the wrist, made probably by the ulnar flexors of the wrist and the *palmaris longus*, seems to show conclusively that the hand was habitually flexed on the wrist and that no great extension can have been possible. The movements of the carpus are entirely a subject for speculation. It seems probable, however, that they were very free in various directions. Pronation and supination were doubtless performed at the shoulder and wrist, with the help of some change in the amount of extension at the elbow aided by vague lateral movements.

A very curious feature of this extremity is the evident attempt of the extra ulna to

imitate a radius. On the front of the projection of the coronoid process is a surface resembling a part of the head of a radius and the lower end is broader than that of the ulna proper. Evidently the bone which developed as a supernumerary ulna made, so to speak, an effort to adapt itself to the functions of a radius.

It is curious also to notice the change in the arteries from the normal type. Thus the brachial after a high division gave off an ulnar which runs deeply and gives origin to the interosseous, as is natural. The other branch runs at first superficially like a radial and then changes into an ulnar giving, as does the other, a characteristic deep branch to the palm.

Still more curious is the origin from the musculo-spiral nerve of a branch in the place of the radial which becomes an ulnar.

We now come to the most important part of the discussion, namely, to the resemblance of the best described of the cases of this deformity to each other. It is more important than the aetiology, for any prospect of solving that question is extremely remote, while there is reason to hope that this dissection will serve as a clue to some of the cases already described. We shall now take in turn several of the features of this case. The one with which it shows a very striking resemblance is that recently reported by Jolly. In both the persons were German males and in both the deformity was on the left side. Dr. Jolly's patient was of a peculiar mental and moral organization. There is some (but not conclusive) reason to think that the same could be said of this individual. In Dr. Jolly's case there was flattening in the deltoid region and an inability to raise the arm above a horizontal line. The scapula is peculiar in this case and there is indication of weakness in the same region. In both cases the affected arm was shorter. What can be felt about the elbow in Jolly's case agrees almost perfectly with the conditions of this one. Dr. Jolly states that where the *biceps* should be there is felt a strong bony ridge ending in a blunt prominence. This is the supernumerary internal condyle which may have had a stronger development than in this case. It is perhaps not impossible that the strong muscular or tendinous band running to it may have given the impression that the bone extended higher than was really the case. The restriction of angular motion and the almost complete absence of pronation and supination give strong confirmation of the similarity of the joints. The photograph shows something of a tendency to flexion and pronation of the hand at the wrist, which Dr. Jolly does not allude to, but it certainly is far less marked than in this case. It is hardly possible to doubt that, except in the condition of the wrist, the cases were similar in all important respects. It is not easy to guess what relation there can be between want of development of the shoulder muscles and this malformation of the hand and arm; but the simultaneous occurrence of these conditions in two cases cannot be regarded as accidental.

Mr. Murray's case is less fully reported and seems somewhat difficult to class with

these two, but I believe it belongs with them. In two respects the case agrees with the present one: flexion at the elbow is very limited, and when working on the floor the woman supported herself on the back of the flexed carpus. This suggests a flexed position of the hand. The metacarpus was also, as in this case, strongly arched. Mr. Murray says that after many examinations he feels sure that the duplicity begins at the carpus. This means that there is no third or fourth bone in the forearm. It implies no reflection on him, to say that the idea of there being two ulnae and no radius may never have occurred to him. He finds a bony impediment to flexion at the elbow which he thinks is an unusually large coronoid. But such a malformation is, so far as I know, unheard of. Is it not more plausible in the light of these observations to believe that the obstacle was the supernumerary internal condyle or perhaps the inverted olecranon? Pronation and supination, he says, were freely performed. This is certainly a very serious difficulty. One might question, however, in the first place whether "freely" is equivalent to "perfectly"; and it must be remembered that to one not very much on his guard these movements are very deceptive. The part played by the shoulder is greater than is often believed. It is moreover not impossible that the articular surfaces at the elbow may have been such as to allow a certain amount of irregular motion, which with the aid of the shoulder and wrist joints, may have permitted a fair amount of twisting of the hand. With all respect to Mr. Murray I can but think it most likely that the forearm consisted of two ulnae.

In the cases of Du Courai and of Funagalli (Nos. 4 and 10) the hands could not be extended. As has been already pointed out, seven of these cases showed fusion of the ulnar sides of the hands with more or less suppression of the radial sides. The descriptions of most of the cases are very inadequate. Many of them are in children, in whom perhaps a want of the proper motions of the elbow would be more easily overlooked. It is probably more likely that such an oversight occurred, than that cases in which the hands were evidently fused, as in this specimen, should have had forearms of the normal structure. The chief importance of this observation is that in connection with Dr. Jolly's case it goes far to establish a type of a certain kind of polydactylism resulting from the fusion of the ulnar portions of two hands. As has been pointed out, in all the cases recorded in this paper, in which there is any statement of the fact, the fusion was of the ulnar portions of the hands, excepting in cases 1 and 2 and in 15, the remarkable observation by Carré, in which there was an additional thumb and forefinger and an extra radius. It is to be noticed in all these cases, which are at all adequately described, that the hands are fused by corresponding sides. There is no instance of the ulnar side of one hand being joined to the radial side of the other.

The question as to the cause and the process of production of this deformity is very interesting but very obscure. The theory that amniotic folds may have caused a muti-

lation, probably a splitting, which is followed by an attempt at duplication, is at first sight a very attractive one. Certain experiments on lizards' tails give it support from analogy. It accounts for cases in which the lesion was so slight that but a part of one finger is involved, or so deep as to affect a whole extremity. There are, however, certain very serious difficulties. What, it may be asked, becomes of the parts that should form the radial side of the hand in a case like the present one? Another difficulty is that in a large proportion of the cases both hands and both feet are affected. Zander¹ argues that there is no impossibility in the occurrence of symmetrical lesions by the amnion. In support of his views it may be stated that very often, perhaps usually, these malformations of both sides are not absolutely symmetrical, and therefore the more likely to have such an injury for their proximate cause. If these objections can be met this seems the most promising theory. Taruffi, while admitting our ignorance, speaks of "exaggerated gemmation," which conveys no explanation. All are now agreed that there is nothing to be said in favor of a double germ. It is remarkable that this view should have survived so long. A century and a half ago M. de Mairan² wrote on this subject: "*Il faut dévorer bien des prodiges, lorsque on dit du bout des lèvres que la formation des monstres peut être expliquée par la confusion des germes.*"

DESCRIPTION OF PLATES.

The following letters have always the same significance. E, the fused external condyles; I, the normal internal condyle; I₂, the extra internal condyle; O, the normal olecranon; O₂, the extra olecranon.

PLATE 43.

1. Cast of forearm and hand, showing the back of the elbow and the palm of the hand.
2. The same cast, showing the back of the hand.
3. The scapula and upper part of humerus.
4. Back and outer side of elbow.
5. Front of elbow.

PLATE 44.

1. Front of the upper end of the ulnae. R indicates an articular surface on the front of the extra ulna simulating a part of a radius.
2. Lower end of the humerus seen from below. The anterior surface is above.
3. Lower end of the humerus seen from the outer side.
4. A model, showing the nature of the malformation. The piece of the extra humerus should, perhaps, have been put on so as to form more nearly a right angle with the left humerus.
5. The front of the wrist and hand. U A, ulnar artery; U A₂, extra ulnar artery; U N, ulnar nerve; U N₂, extra ulnar nerve. M, M, branches of median nerve.

¹ Virchow's Archiv, Bd. 125, s. 479 and 480. 1891.

² Hist. Acad., 1742.



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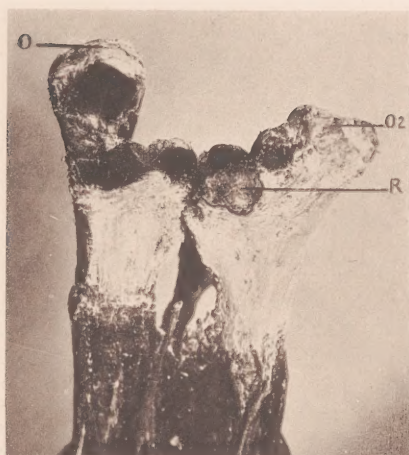
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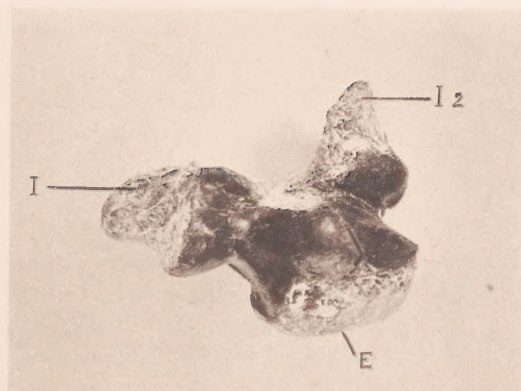
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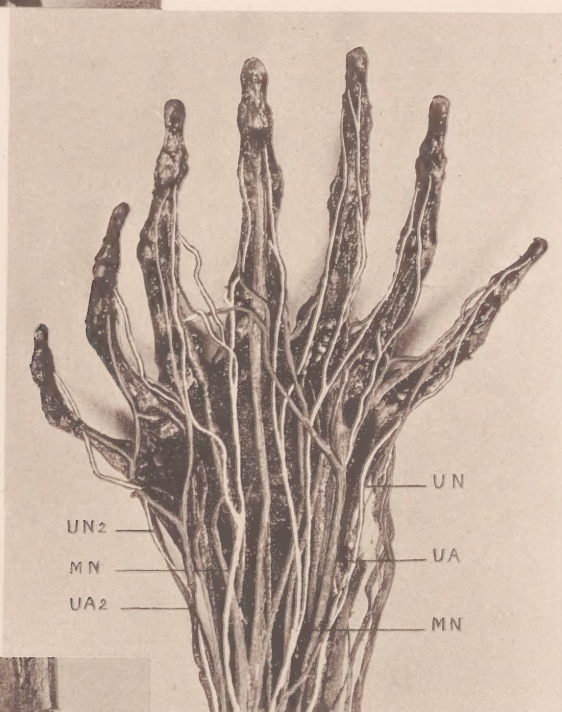
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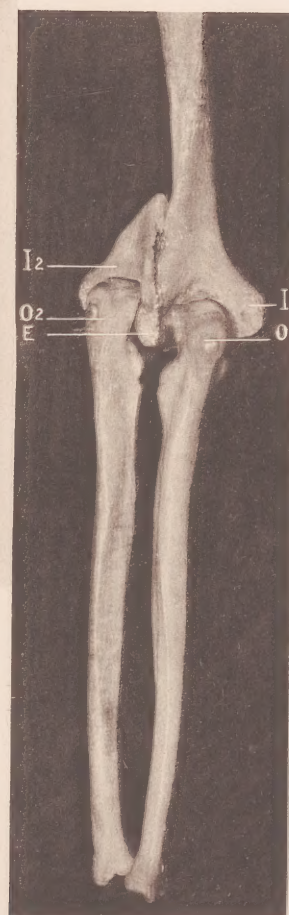
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